Exploiting Iron's Attraction to Oxygen to Prevent Corrosion Using Bound Biofilm Molecules

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Introduction

Biofilms, such as those generated by fungi, are capable of shielding fungal and even bacterial colonies from destruction when exposed to extremes of temperature as well as chemical insults. When one endeavors to eliminate bacteria or fungus from a surface or a material, one must first remove the biofilm in order to ensure that the antibacterial or antifungal agent is able to do its job.

Abstract

Biofilms are intrinsically air and watertight, meaning that anything coated in a biofilm, so long as that biofilm remained in place, would tend to remain resistant to oxidation and resultant corrosion.

The bond that links oxygen with iron is extremely strong, meaning that once iron has been oxidized, it is very difficult to reverse this process of oxidation. Corroded metal can be debrided from uncorrupted metal, but removing oxygen from iron is an impractical process. Furthermore, once iron has infiltrated iron, the relative structure of its atoms is changed in such a way that its tensile strength is substantially reduced. Corrosion-resistant coatings have as their weakness that even corrosion-resistant materials such as chromium eventually rust and thin coatings tend to wear away over time. The structural integrity of many structures is often undermined not by the loss of integrity of large components that are easily repaired (such as ship hulls and structural support beams) but rather, the smaller metallic components such as nuts and bolts that join important structural components together.

These smaller components are difficult to access and need to be replaced entirely according to a pre-set schedule. Oftentimes, metal bolts may appear to be in good condition while their interior has been weakened by corrosion caused by unseen infiltration by moisture. A novel approach is called for in order to prevent the corrosion of all metallic components of important structures in order to extend their useful longevity and reduce maintenance costs while increasing safety.

Biofilms may be coupled with metallic surfaces, particularly iron, by using oxygen molecules as a bridge that connects biofilm molecules with iron molecules. A single oxygen molecule would be made to connect (on one side) with an atom along the surface of a metallic object to be protected from corrosion as well as another iron molecule embedded within a biofilm

nanosphere which would act as an anchor for the O2 molecule on the opposing side.

As the oxygen molecule would never be able to migrate to the inboard side the first atomic thickness of iron the biofilm protects, it would never lose its structural integrity as rust ordinarily would. Its oxygen component would always be facing in the outboard direction and would always have as its intermediary the biofilm, preventing any further oxygen from entering into the protected material.

In just this way, permitting the oxidation process to begin in its most nascent stage forms the basis of a highly effective approach to corrosion-prevention.

Conclusion

Embedding iron within biofilms would be a low-cost endeavor as this would merely entail the cultivation of fungi within an iron-rich environment. Perhaps the greatest technical challenge would lie in the insertion of a single O2 into the wall of the biofilm, a process which would call for a high degree of precision in terms of O2 flow and air pressure control. Once this is achieved, the interior Fe atom would naturally migrate toward the O2 and, upon the biofilm's application to the surface, the other side of that O2 would naturally attach to the iron.

An open question is one of to what extent such films are resistant to extremes of temperature as well as their longevity when compared to other coating approaches. The mechanistic action of the joined molecules would approximate that of a snap rivet, a structure that easily joins two structures in such as way that it would be difficult to reverse the process while preventing, in this case, oxygen from migrating past the seal created by the proximity of the biofilm to the protected surface.